DOCUMENT RESUME

ED 216 858 SE 037 100

AUTHOR Yeany, Russell H.; Porter, Charles F.
TITLE The Effects of Strategy Analysis on Science Teacher Behaviors: A Meta-Analysis.
PUB DATE Apr 82
NOTE 16p.; Paper presented at the National Conference of the National Association for Research in Science Teaching (Chicago, IL, April 1982).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classroom Observation Techniques; Elementary School Science; Elementary Secondary Education; Feedback; Microteaching; Nonverbal Communication; Observation; Science Education; *Science Teachers; Secondary School Science; *Teacher Behavior; Teacher Characteristics; Teaching Models; *Training Methods; Verbal Communication
IDENTIFIERS *Meta Analysis; *Science Education Research

ABSTRACT

Meta-Analysis procedures were employed to integrate existing science education research findings on the effectiveness of teaching strategy analysis training to: (1) determine overall magnitude of effect that can be expected from such training; (2) determine and compare relative magnitude of effects attributable to various approaches to such training (for example, self-analysis versus analysis of models, or microteaching versus no microteaching); (3) examine the relationship between the effect and the school level of the teacher (elementary, middle, or high school); (4) compare the effects when measured directly by recording teacher behaviors versus more indirectly when measuring student behaviors; and (5) calculate the effects assessed through behavioral versus cognitive or affective outcomes. Studies selected included those with sufficient statistical data to derive an effect size for treatment in the study (difference between baseline mean and treatment group mean in units equal to standard deviation of baseline data). Results indicated: (1) teaching strategy analysis is an effective training procedure; (2) all procedures presented had a positive impact on teachers' behavior, especially the use of models and providing systematic feedback (method of choice); and (3) positive effect sizes in cognitive and affective areas and across educational levels. (Author/JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED216858

The Effects of Strategy Analysis on Science Teacher Behaviors: A Meta-Analysis

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Russell H. Yeany
and
Charles F. Porter
Department of Science Education
University of Georgia

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
RUSSELL H. YEANY

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

A Paper Presented
at the
National Conference
of the
National Association for Research in Science Teaching
Chicago, Illinois

April 1982

SE 037 100

The Effects of Strategy Analysis on
Science Teacher Behaviors: A Meta-Analysis

In recent years, the effects of teaching strategy analysis on the behaviors of teachers have served as a focus for research in science teacher training. Teaching strategy analysis usually involves some systematic observation and recording of teacher and pupil behaviors within a classroom setting. These behaviors can be verbal, as in questioning level and wait-time, non-verbal, as with laboratory activities, or a combination as is the typical case with classroom demonstrations. These systems have been employed in treatments to influence science teaching behaviors in a variety of ways. The following is a general categorization of treatments using analysis systems with example studies.

Study of an Analysis System (Jacobs, 1973 and Yeany, 1977)

Self-Analysis of Recorded Lessons (Harris, Lee and Pigge, 1970 and Riley, 1980)

Observation of Model Lessons (Koran, 1969, James, 1971, and Koran and Koran, 1981)

Analysis of Model Lessons (Lamb, 1977, Riley, 1978 and Yeany, Okey and Capie, 1978)

Feedback Guided by Analysis System (Raymound, 1973 and Armstrong and Ladd, 1975)

The dependent variables of interest in these studies usually include some which are closely related to the strategy analysis treatment (e.g., questioning level, wait-time, or degree of indirectness) but, some studies include less closely related outcome variables such as teachers, attitudes or their pupils, achievement scores (e.g., Miller, 1980).

PURPOSE

The results of the research described above indicate a positive impact for such treatments. However, because of variations in methods and results of studies examing the effects of strategy analysis training on science teaching behaviors, an integrating analysis of the studies and their results is called for. Glass (1976) suggested that there is a need for a type of integrating research which uses previous findings in a particular area as the unit of analysis. He argued that:

> "In educational research, we need more scholarly effort concentrated on the problem of finding the knowledge that lies untapped in completed research studies....This endeavor deserves higher priority now than adding a new experiment or survey to the pile."

Glass (1978) defined a process for statistically integrating the findings of a set of studies and labeled it meta-analysis (analysis of analyses).

In the present study, meta-analysis procedures were employed to integrate existing science education research findings on the effectiveness of teaching strategy analysis training in order to:

a. determine the overall magnitude of effect that can be expected from such training;

b. determine and compare the relative magnitude of effects attributable to the various approaches to such training (e.g., self-analysis versus analysis of models or microteaching versus no microteaching);

c. examine the relationship between the effect and the school level of the teacher (elementary, middle or high school);

d. compare the effects when measured directly by recording teacher behaviors verus more indirectly when measuring student behaviors; and,

e. calculate the effects as assessed through behavioral outcomes versus cognitive or affective outcomes.

PROCEDURES

Both computer and "hand" literature searchers were employed in identifying and acquiring studies related to the above purpose. These searches identified a body of studies on science teaching strategy analysis and teaching behaviors which examined a total of 188 dependent variables. Subjects used in the combined studies numbered more than 400 elementary, middle and secondary science teachers. In order for a study to be retained for inclusion in the meta-analysis, the following criteria had to be met:

a. treatment had to include at least one of the categories of strategy analysis training mentioned earlier;
b. the focus of the training had to be aimed at science teaching behaviors or related outcomes; and,
c. enough statistical data had to be given to derive effect sizes for the treatments examined in the study.

To determine the impact of treatment, the recommended procedure in a meta-analysis is to calculate an "effect size" which is defined as the difference between a baseline mean (e.g., control group) and the treatment group mean in units equal to the standard deviation of the baseline data. In this case:

$$ES = \frac{\bar{X}_E - \bar{X}_C}{S_{X_C}} .$$

Where one or more of the needed statistics was not reported, the needed information was derived from other reported statistics. For example,

$$S_X = \sqrt{\frac{MS_b}{F}} \qquad \text{and} \qquad ES = t\sqrt{\frac{1}{n} + \frac{1}{n}} .$$

Mean effect sizes ($\overline{ES}$) were calculated for each category of strategy analysis training by comparing the treatment group results with a control within

the same study and then averaging across all the effect sizes for a particular class of treatment. Where more than one outcome measure was employed (e.g., verbal and non-verbal or immediate and delayed effect), an effect size was calculated for each. Thus the unit of analysis in this meta-analysis is the finding and not the study.

RESULTS

As can be noted in Table 1, the overall impact of strategy analysis training on science teacher behaviors shows an effect size of 1.31. A breakdown of the various types of training approaches indicates that feedback guided by analysis is the most effective method ($\overline{ES}$ = 2.30) and analysis of written models is the least effective ($\overline{ES}$ = .65). However, both effect sizes are significantly different from zero ($p < .05$). The use of models (other than written) fall in the middle ground with effect sizes from 1.17 to 1.42. Figure 1 depicts the theoretical distribution of effects for each training approach. The baseline for comparison is the 50th %ile (mean) of the control groups used for comparison in the experimental studies.

Insert Table 1 and Figure 1 here

Table 2 presents effect sizes related to various components of strategy analysis training. As can be noted: micro-teaching produces slightly better results than no micro-teaching; analyzing models is better than simply observing models; employing an analysis system is better than not using one; and, visual or audio models have a decided edge over written models.

Insert Table 2 About Here

Table 1

Summary Of Effect Size Caluculations
For The Impact Of Strategy Analysis Training
On Science Teacher Behaviors

	Training Type	$\overline{ES}$	S	$S_{\overline{ES}}^{*}$	N
1.	Analyzing Written Models	.65	.51	.23	5
2.	Self - Analysis	.72	.48	.15	10
3.	Study of Analysis System	.79	.55	.15	14
4.	Observing Written Models	.84	.39	.11	12
5.	Observing Audio Models	1.17	.95	.26	13
6.	Observing Visual Models	1.30	1.79	.18	19
7.	Analyzing Audio Models	1.40	1.24	.37	11
8.	Analyzing Visual Models	1.42	.73	.08	90
9.	Feedback Guided by Analysis	2.30	2.73	.73	14
	Overall Effect	1.31	1.19	.87	188

* $S_{\overline{ES}}$ Should be interpreted as a lower bound because of the dependency of ES's originating from the same study.

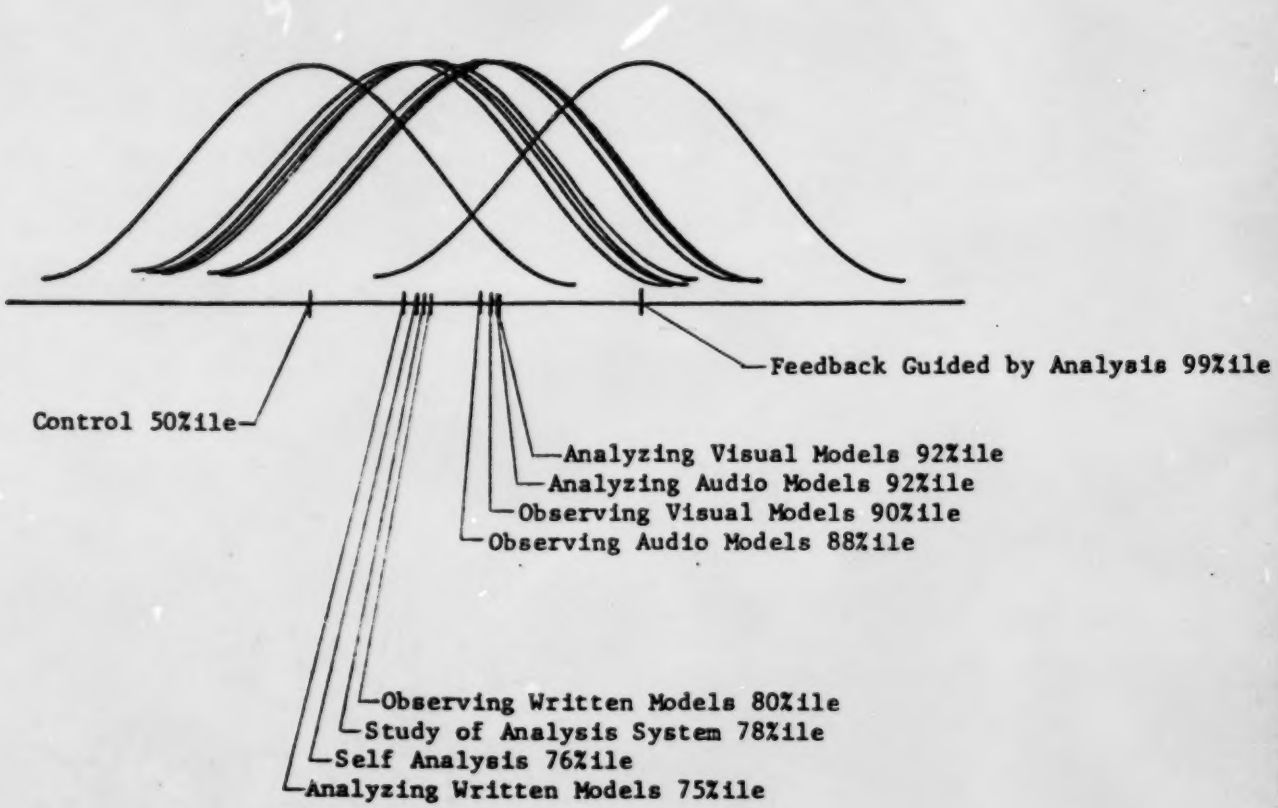

Figure 1. Theoretical Distributions of Effect Sizes for the Various Types of Strategy Analysis Training

TABLE 2

SUMMARY OF EFFECT SIZES FOR VARIOUS COMPONENTS OF STRATEGY ANALYSIS TRAINING

	$\overline{ES}$	S	$S_{\overline{ES}}$	N
MICRO TEACHING INVOLVED	1.41	1.47	.15	102
NO MICRO-TEACHING	1.21	.73	.08	86
ANALYZING MODELS	1.38	.80	.08	106
OBSERVING MODELS	1.14	.129	.20	44
ANALYSIS SYSTEM USED	1.37	1.16	.10	144
NO ANALYSIS SYSTEM	1.14	1.29	.20	44
WRITTEN MODELS	.78	.42	.10	17
AUDIO MODELS	1.28	1.08	.22	24
VISUAL MODELS	1.40	.99	.08	109

In regard to the school level of the teacher and whether the outcome subject is teacher or pupil, assessment of teachers measures the greatest impact of training; while, elementary teachers are more responsive to training ($\overline{ES}$ = 1.66) with middle and high teachers lower and nearly equal ($\overline{ES}$ = 1.26 and 1.27) (see Table 3).

Insert Table 3 About Here

Various outcomes were examined in the meta-analysis and grouped under three types: (1) verbal behaviors; (2) non-verbal behaviors; and, (3) non-behaviors (e.g., skill tests or affective measures). Table 4 shows that the greatest impact appears in verbal behaviors followed closely by non-verbal ($\overline{ES}$ = 1.54 and 1.32). Other outcomes showed a smaller effect size of .57.

Insert Table 4 About Here

SUMMARY

The results of meta-analysis indicate that teaching strategy analysis is an effective science teacher training procedure. Although all procedures presented show positive impact on the teachers' behaviors, the use of models and certainly providing systematic feedback should be the method of choice. Also, the greatest impact can be expected on behavioral outcomes. This is not surprising since these are the targeted variables in this type of training. But, it is encouraging to see a significant positive effect size for the more ancillary findings in the cognitive and affective areas.

The fact that the effect holds up across grade level is also important. Even though elementary teachers are the most responsive, the effects hold up

TABLE 3

MEAN EFFECT SIZES MEASURING IMPACT OF STRATEGY ANALYSIS TRAINING ACROSS GRADE LEVEL AND SUBJECT

SUBJECT		GRADE LEVEL: ELEMENTARY	MIDDLE	HIGH	MIXED	
TEACHER	$\overline{ES}$	1.66	1.26	1.27	1.07	1.40
	S	1.74	.39	.88	.42	1.22
	$S_{\overline{ES}}$	.22	.07	.12	.11	.10
	N	62	32	53	14	161
PUPIL	$\overline{ES}$	.03	.86	1.35	.80	.80
	S	.04	.44	1.46	.91	.81
	$S_{\overline{ES}}$	.03	.16	1.03	.23	.15
	N	2	8	2	15	27
	$\overline{ES}$	1.61	1.13	1.27	.93	
	S	1.74	.43	.89	.73	
	$S_{\overline{ES}}$	.22	.07	.12	.13	
	N	64	40	55	29	

Table 4
Mean Effect Sizes Measuring
Impact of Strategy Analysis Training
Across Outcome Type

Outcome Type	$\overline{ES}$	S	$S_{\overline{ES}}$	N
Verbal Behavior	1.54	1.68	.21	67
Non-Verbal Behavior	1.32	.76	.08	100
Non-Behavior (Cognitive & Affective)	.57	.60	.13	21

across other levels or even mixed groups and do not indicate a need for different training strategies.

A final word of caution related to interpretation needs to be added. A meta-analysis procedure tends to blend treatment types and more so outcomes. As a result, some training procedures which were matched very closely to the expected outcomes in the original studies are no longer distinct. Therefore, any selection of training procedures should result from logically matching the process to the desired outcome.

References

Armstrong, E.G., & Ladd, G.T. Rotating peer supervision: implementation and evaluation of its effect on the inner-direction and internal control constructs of teacher trainees. A paper presented at the National Association for Research in Science Teaching annual meeting, Los Angeles, California, March 1975. (ERIC No. ED 115 469)

Glass, G.V. Primary, secondary and meta-analysis of research. Educational Researcher, 1976, 5(10).

Glass, G.V. Integrating findings: the meta-analysis of research. In Shylman, L. (Ed.), Review of Research in Education, Itasca, IL: Peacock Publishing, 1978.

Harris, W.N., Lee, V.W., & Pigge, F.L. Effectiveness of micro-teaching experiences in elementary science methods classes. Journal of Research in Science Teaching, 1970, 7(1), 31-33.

James, H.H. Effects of supervisory methods upon development of a teaching strategy by student teachers. Journal of Research in Science Teaching, 1971, 8(4) 335-338.

Jacobs, J.H. Insight learning through structured observations of classroom interaction. Journal of Research in Science Teaching, 1973, 10(3), 213-220.

Koran, J.J., Jr. The relative effects of classroom instruction and subsequent observational learning on the acquisition of questioning behavior by pre-service elementary science teachers. Journal of Research in Science Teaching, 1969, 6(3), 217-223.

Lamb, W.G. Evaluation of a self-instructional module for training science teachers to ask a wide cognitive variety of questions. Science Education, 1977, 61(1) 29-30.

Miller, P.A. The effects of behavior model analysis and formal reasoning ability on science activity lesson behaviors of teachers. A paper presented at the annual meeting of the National Association for Research on Science Teaching, New York, 1981.

Raymond, A. The acquisition of nonverbal behaviors by preservice science teachers and their application during student teaching. Journal of Research in Science Teaching, 1973, 10(1), 13-24.

Riley, J.P., II. Effects of studying a question classification system on the cognitive level of preservice teachers' questions. Science Education, 1978, 62(3), 333-338.

Riley, J.P., II. The influence of systematic analysis of self and peer taught videotaped lessons on teacher instructional behavior. A paper presented at the Association for the Education of Teachers in Science annual meeting, Anaheim, California, March 1980.

Yeany, R. The effects of model viewing with systematic strategy analysis on the science teaching styles of preservice teachers. Journal of Research in Science Teaching, 1977, 14(3), 209-222.

Yeany, R.H., Okey, J.R., & Capie, W.R. The effects of process skill analysis on the teaching of data collecting, processing and interpreting. A paper presented at the National Association for Research in Science Teaching annual meetings, Toronto, Canada, April 1978.